Journal of Bioresource Management

Volume 7 | Issue 1 Article 9

3-31-2020

Nutritional Evaluation of Maize Plant Fodder Grown in Spring and Autumn Season in Punjab, Pakistan

Nafeesa Qudsia Hanif
AgriPak Labs, Rawalpindi, Pakistan, nafeesahanif9@gmail.com

Nadeem Akhtar
Institute of Natural and Management Sciences (INAM), Rawalpindi

Recommended Citation

Hanif, N. Q., & Akhtar, N. (2020). Nutritional Evaluation of Maize Plant Fodder Grown in Spring and Autumn Season in Punjab, Pakistan, *Journal of Bioresource Management, 7* (1).
DOI: https://doi.org/10.35691/JBM.0202.0123

NUTRITIONAL EVALUATION OF MAIZE PLANT FODDER GROWN IN SPRING AND AUTUMN SEASON IN PUNJAB, PAKISTAN

NAFEESA QUDSIA HANIF*[1] AND NADEEM AKHTAR[2]

[1]*AgriPak Labs, Rawalpindi, Pakistan*
[2]*Institute of Natural and Management Sciences (INAM), Rawalpindi*

*Corresponding author: nafeesahanif9@gmail.com

ABSTRACT

Present study was planned to assess the nutritional evaluation of maize plant grown in spring and autumn seasons. For this purpose, a total of 277 (n=130 in spring and n=147 in autumn season) samples were collected from high maize-growing localities i.e. Kasur, Pakpattan, Okara, Burewala, Sahiwal, Lahore and Melsi. These samples were analyzed for different parameters such as dry matter (DM) and Crude protein (CP) etc. It was noticed that during spring season the values of dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF) and starch were significantly higher than autumn season values. On the other hand, crude protein (CP) was higher in maize grown in autumn season. Furthermore, dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF) and starch were low in autumn sampling than spring season. The evident difference showed that during autumn season, at the time of growing season, the seasonal conditions are tough which gradually become favorable from nutrients point of view. While the maize grown in spring season found suitable environment which gradually harshen at the time of harvest. Therefore, it is suggested to cut the spring-crop early in spring during the month of May-June to have better nutritional value.

Key words: Maize, silage, nutrition, energy, seasonal variation

INTRODUCTION

Maize (*Zea mays L.*), a perennial crop, belongs to Poaceae (Gramineae) family. The importance of maize ranks at third number, after wheat and rice in Pakistan (Tariq et al., 2010). It is grown on an area of 1,318,000 hectares with an annual production of about 6,309 metric tonnes (Economic Survey of Pakistan; 2018-19). Its utilization in the feed and wet milling industry is growing exponentially in Pakistan. It is grown in almost all major agricultural lands of the country. Punjab and KPK are the major maize-producing provinces.

Maize is grown three times during a year in Pakistan. However, spring and autumn seasons are suitable for its cultivation. Spring maize can be planted from starting week of February till the first week of March. Autumn season maize can be grown from ending week of July which ends in the mid of August. Cultivation of maize in spring season is higher than autumn season. Involvement of multinationals in Pakistan has increased cultivation of spring maize. The yield of spring maize is lower than its actual potential due to constrains such as haphazard use of synthetic fertilizers, old and traditional sowing methods and scarcity of optimal crop stand. The maize grain is enriched with necessary nutrients as it contains 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugar and 1% ash (Enyisi et al., 2014).

The nutritious fodder of maize is

relished by all kinds of livestock especially the ruminants. Livestock industry plays a pivotal part in the agricultural unit of Pakistan. The capacity of the lactating animals to produce milk is below their inherent potential. The main reasons for low productivity are the insufficient and imbalance feeding, lack of reproductive skills, attack of different diseases and shortage of many support activities/services such as artificial methods of insemination.

In order to meet the demands of dairy products such as meat and milk in the country, livestock sub-sector needs to be exploited. There are many factors for fodder scarcity such as shrinking of area under fodder cultivation, shortage and inconsistent supply of quality and quantity of animal feed round the year. Usually ruminants are not provided with high quality roughages. These roughages are poor in basic nutritional value. According to a study, in Pakistan the available fodder production is not up to the mark and it is approximately 52-54% less than actual requirement of the ruminants (Khan et al., 2014).

According to the findings of Sultan et al. (2007) there is a need of 13.5 and 110.3 million tons of crude protein and total digestible nutrients respectively to maintain the health of livestock. While the present available feed sources provide only 40% crude protein and 75% total digestible nutrients. There are two periods in Pakistan in which the fodder scarcity takes place. One is during winter months (November to January) while the other period is in summer months (May to July). During rest of the year, fodder availability is almost regular and abundant.

The fodder is rich in nutrients and it can be saved to fulfill the requirements in days of scarcity. Silage-making is an important technique in this regard (Touqir et al., 2007). The main goal of silage making is to preserve the extra fodder and its nutritional value without scarifying the area under cash crops. In the ensiling process, preservation is achieved by maintaining anaerobic (oxygen free) environment and acidity. The bacteria present on fodder produce acids that convert fermentable carbohydrates into different organic acids especially lactic and acetic acids. High acid concentration drops the pH which ultimately inhibit/kills most of the bacteria and other microorganisms. At this pH, anaerobic environment and water seepage maintenance, the silage can be preserved for longer periods.

The concentration of fermentable carbohydrates in the forage, its buffering capacity, dry matter content (DM) and the number and type of bacteria present on forage are the main factors that could affect the rate of decline and final pH of the silage. Basic need to make silage is fermentable starch. Any fodder containing enough quantity of fermentable carbohydrates makes it a strong candidate for silage-making, but nowadays maize is a well-known fodder to make silage. The local environment is the primary factor for crops to be ensiled. Studies have shown that the soil, rainfall, season, chemical nature and age of plants affect the quality of forage, its palatability and health of grazing animals (Ganskopp and Bohnert, 2001). The nutritional value of available forage is responsible for the health of livestock. It therefore, becomes necessary for the stockmen and crop managers to be well aware about the nutritional status of forage.

In Pakistan, silage making is in practice since last two decades. Maize crop is cultivated three times a year in Pakistan. Mainly two crops grown during spring and autumn season, selected for silage making. The maize crop is well-studied and explored with respect to quality. However, the nutritional variation during different cropping seasons has been ignored.

Therefore, present study was conducted to evaluate the nutritional status of maize grown in different areas of central and southern Punjab during spring and autumn season.

MATERIALS AND METHOD

Sampling

A total of 277 (n=130 in spring and n=147 in autumn season) whole maize plants were collected from the localities of Kasur, Pakpattan, Okara, Burewala, Sahiwal, Lahore and Melsi (Punjab) during May to July (Spring cultivation) and September to November (Autumn cultivation) of year 2015. The whole maize plants with combs were chopped to about 2-3 cm in length and dried in hot air oven at 65°C. Dried samples were then grinded using grinding mill (RAS mill Series II, Romer, USA). Samples were stored in air tight polythene bags at dry place. These samples were then put forth for the chemical analysis to assess their nutritional variation during two seasons.

Nutritional analyses

Proximate analysis of maize samples is mentioned in successive section:

1. Dry Matter (DM) / Moisture

The percentage of dry matter and moisture was determined by AOAC official method No.934.01. Each sample was dried to constant weight by placing in an oven at 65^0C overnight. Prior to sample shifting in oven, these chopped whole plant samples were packed in paper bags/ envelops and placed in sunlight. Once, the DM was achieved up to 50% then samples were placed in hot air oven. Finally, the moisture content of each sample was determined as the difference in weights before (W_1) and after (W_2) drying and percent moisture was calculated by using following formula:

$$\text{Moisture (\%)} = W_1 - W_2 \times 100 / \text{weight of sample}$$

$$\text{Dry Matter (\%)} = 100 - \text{Moisture}$$

2. Crude protein (CP)

The percentage of crude protein was estimated by official method No. 954.01. An amount of 2 grms of ground and homogenized sample was taken into a micro-kjeldhal digestion flask. About 5 gram of digestion mixture (100g K_2SO_4 + 10g $CuSO_4$ + 5g $FeSO_4$) was added along with 40 mL concentrated sulfuric acid (H_2SO_4). For digestion, the flask was placed on heater with medium temperature setting. The digestion was completed in 3-4 h until the solution became clear. The contents of flask were cooled down and transferred to volumetric flask to make dilution up to 1 liter with water. A 10 mL aliquot of this dilution was transferred into a micro-kjeldhal distillation apparatus along with 10 mL of 40 % sodium hydroxide (NaOH) solution and boiled for distillation. The liberated ammonia was condensed and collected into a beaker containing 2 % boric acid. In a 100 mL conical flask containing 2-3 drops of mixed indicator (0.1 % BCG and 0.1 % methyl red in 95 % alcohol) 50 mL of ammonia condensate was added. The ammonia condensate was titrated against 0.01 M HCl and light pink color was recorded as end point. The crude protein was calculated by applying following formula:

$$\textit{Nitrogen (\%)} = N \times T \times 250 \times 0.0014 \times 100 / W$$

$$\textit{Crude protein (\%)} = \textit{Nitrogen (\%)} \times 6.25$$

3. *Ether Extract/ Crude Fat (EE)*

The percentage of ether extract was determined by AOAC official method No. 920.39. Three grams of dry sample were taken in a fat free thimble and placed in the

Soxhlet's apparatus. The apparatus was adjusted with receiver containing n- hexane at 80 ºC in a water bath. It was heated for 4h at the rate of about 80-90 drops per minute. After 4h the thimble was removed. Above process was repeated in order to recover the excess solvent until about 2-3 mL hexane remained in the receiver. The contents of the receiver were transferred to pre-weighed petri dish (W_1). They were given 2-3 washings with n-hexane and the aliquot was collected in the petri dish. The petri dish was placed in an oven at 70ºC until all the solvent was evaporated. Sample was cooled down in a desiccator and then weighed (W_2).The percentage crude fat / ether extract was calculated by following formula:

Ether Extract (%) = $W_2 – W_1$ x 100 / Wt. of sample

4. Crude Ash (CA)

The percentage of crude ash was determined by following AOAC official method No.942.05. Two grams of sample was weighed in the pre-weighed crucible (W_1) and charred at oxidizing flame till no more fumes evolved. Then it was shifted to a muffle furnace at 550-600 ^{0}C for 2h followed by cooling in desiccator and weighed as (W_2). The percentage of crude ash was calculated as:

Crude Ash (%) = 2 – ($W_1 – W_2$) x 100 / weight of sample

5. Neutral Detergent Fiber (NDF)

The percentage of neutral detergent fiber was determined by following AOAC official method No. 989.03. An amount of 1.5 g of grinded and homogenized sample was taken in conical flask. 0.5 gram of sodium sulphide (Na_2S) was mixed with sample in flask for good digestion and to that 100 mL of NDF solution was added. The flask was heated on plate until it started boiling. The flask was covered with another small flask. Steam produced in this way was condensed and increased the process of digestion. It took 1:30h. The solution was then filtered through ordinary cloth with the help of suction pump. The residue on the cloth was washed with hot water. The collected sample was dried in an oven at 105^0C for few h till the weight became constant and it was reweighed and percentage NDF was calculated as follows:

NDF (%) = ($W_2 – W_1$) x 100 /sample weight

6. Acid Detergent Fiber (ADF)

A 1.5 g of dried sample was weighed in a 500 ml conical flask. About 100 ml of acid-detergent solution and covered with conical flask of 250 ml in inverted form and on heater. It was boiled for 5-10 min, then the heat was reduced to avoid foaming as boiling begins. The sample was refluxed for 60 min from the onset of boiling. The flask was shaken occasionally to avoid any sample part getting stuck to the inner wall of flask. On completion, the flask was removed, swirled and filtered through filter with boiling water. Lastly, residue was given an acetone wash just to ensure the removal of ADF solution residue if any. The whole residue was collected in pre-weighed crucible (W_1). The residue was dried till constant and weighed (W_2). ADF was calculated by using following formula:

ADF (%) = ($W_2 – W_1$) x 100 / sample weight

7. Nitrogen Free Extract (NFE)

The NFE contents of the samples were determined by calculation by using the following formula:

Nitrogen Free Extract (%) = 100 – (CP + EE + CF + CA)

8. Starch

The percentage of starch was determined by following AOAC official method No.

948.02. A small amount of about 0.01 g of sample was taken in a 25 mL falcon tube and 5 mL of acetone was added in it. It was centrifuged for 25-30 minutes (to remove colored pigments). The acetone was removed and dried the sample in the same falcon tube. The sugars were extracted with 2.5 mL of 80% ethanol. It was centrifuged again and the supernatant was kept for soluble sugar analysis. 5mL of 1.1% HCl was added to the residue and heated in a water bath at 100 ^{0}C for 30 minutes. It was diluted to 10 mL with deionized water. Finally, the absorbance was observed at 490 nm in the UV spectrometer. A standard curve was drawn with standard solution concentrations i.e. 0.00, 0.01, 0.02, 0.04, 0.06 and 0.08 and 0.1mg/mL. The R^2 (Linear Regression) for the curve was recorded as 0.9709 (Figure 1).

9. Total Digestible Nutrients (TDN)

The TDN values of the samples were determined by regression equations (NRC, 2001) and software (UC Davis, California).

10. Energy Parameters

Energy parameters were calculated by derived equations (NRC, 2001).

Statistical Analysis

Treatment effects used as parameters of nutrients, on collected samples were compared by using the least significant difference (LSD) method. Any significance difference found has been presented in the form of probability (p) values using Duncan test by SPSS software.

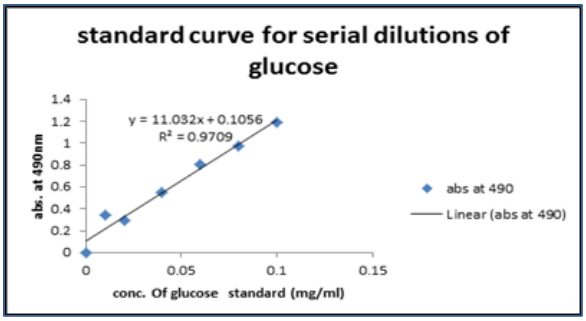

Figure1: Calibration curve for starch by using serial dilutions of glucose standard solution (mg/mL).

RESULTS AND DISCUSSION

The nutritional quality of ensiled maize forage is very important and it has to be used during OFF season (means when no fresh fodder is available for the animals). Therefore, present study was conducted with the hypothesis, "Does season affect nutritional parameters of maize grown in same area". For this purpose, a total of 277 samples were collected during spring season (n=130) and autumn season (n=147) from Kasur, Pakpattan, Okara, Burewala, Sahiwal, Lahore and Melsi. These samples were put forth for their nutritional assessment. The data was explored with respect to the comparison among the growing areas and then between two seasons in successive section.

Tables 1 and 2 describe an overview of nutritional profile of samples during spring and autumn seasons. It was noticed that during spring season percent mean dry matter content with 34.20% value was higher than the values observed during autumn i.e. 33.30%. It was probably the weather conditions and harvesting time. Moreover, the spring season gradually become harsh due to rise in temperature and decrease in soil moisture. Dry matter also increases with plant maturity and application of nitrogen fertilizer (Ayub et al., 2002).

During spring season, a cumulative crude protein content with 6.78% value was observed; lower than the values observed during autumn season i.e. 7.45%. There are two important factors which affected the yield and quality of fodder crops i.e. proper time of harvesting and application of nitrogen fertilizers. Crude protein was observed high at early vegetative growth stage of grain i.e. at half milk line stage of grain. Delayed harvesting time resulted in decreasing crude protein contents (Siddique et al., 1989). Crude fat/ether extract content with 1.77% and 1.74% values were non-significantly different during spring and autumn season. The cumulative crude ash content in spring season was 4.89% and it was 4.57% in autumn season. There was non-significant difference in ash content of two seasons. Crude fiber content in spring season was 23.77%, while in autumn season its value was 23.64%. Crude fiber content increased with plant growth and maturity. The effect of seasonal changes was significant because fiber content increased with loss of moisture content in spring season, as harvesting time was in high temperature duration. It was low in autumn due to low temperature and high humidity in the environment. High crude fiber content showed low digestibility compared to other cell contents.

Similarly, neutral detergent fiber and acid detergent fiber with values of 52.92% and 27.35% respectively in spring season were higher than autumn season values of 48.77% and 25.45%. These high values of NDF & ADF showed low nutritional / digestible values. Again these high values in spring season were due to harsh environmental conditions at harvesting time and decrease in soil moisture. Starch content in spring was greater (27.68%) as compared to autumn season value i.e. 24.46%.

High level of starch in maize fodder is good for animals because it is easily digestible and provides energy readily. The amount of starch increased with maturity of plants under low moisture and high temperature. Nitrogen free extract (NFE) was not affected by seasonal variations as the spring season value (62.73%) was close to autumn season value of 62.56%. As far as digestibility and energy parameters are concerned, it was observed that on the whole, non-significant variations were present between spring and autumn season. However, some variation in different energy parameters among sampling areas was observed. Kasur showed maximum value of crude protein with respect to mean value while Melsi showed the deficient value of crude protein in spring season.

Table 1. Chemical composition (%) of maize fodder collected from various localities of Punjab during spring season.

Locality	Dry matter (%)		Crude Protein (%)		Crude Fat (%)		Crude Ash (%)		Crude Fiber (%)		Neutral Detergent fiber (%)		Acid Detergent Fiber (%)		Starch (%)		Nitrogen free extract (%)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Kasur	34.40^{c}	1.42	6.79^{b}	0.60	1.73^{a}	0.15	5.78^{b}	1.00	23.89^{abc}	3.22	56.96^{d}	2.07	26.25^{a}	2.42	30.33^{c}	3.19	61.79^{ab}	3.07
Pakpattan	31.96^{a}	1.37	6.85^{b}	1.04	1.77^{a}	0.15	4.72^{a}	0.64	22.42^{a}	1.18	54.21^{bcd}	4.90	27.46^{a}	2.28	26.84^{b}	5.11	64.22^{c}	1.73
Okara	32.51^{ab}	1.69	7.26^{b}	0.93	1.76^{a}	0.13	4.95^{a}	0.73	22.92^{ab}	1.24	48.32^{ab}	1.47	26.33^{a}	1.96	22.17^{a}	5.62	63.07^{bc}	2.09
Burewala	32.20^{a}	0.69	6.78^{b}	0.61	1.71^{a}	0.19	4.52^{a}	0.44	24.20^{bc}	2.90	59.18^{d}	2.96	26.65^{a}	2.60	30.65^{c}	1.83	62.768^{abc}	2.87
Sahiwal	32.26^{a}	1.39	7.05^{b}	0.71	1.83^{a}	0.17	4.73^{a}	0.63	22.83^{ab}	1.21	45.88^{a}	1.48	29.12^{b}	4.19	29.99^{c}	2.97	63.54^{bc}	0.93
Lahore	34.02^{bc}	3.67	7.35^{b}	1.14	1.77^{a}	0.19	4.86^{a}	0.66	24.89^{c}	2.42	49.69^{ab}	1.24	27.71^{ab}	1.73	22.07^{a}	2.03	61.11^{a}	3.00
Melsi	42.08^{d}	2.16	5.41^{a}	0.54	1.86^{a}	0.20	4.71^{a}	0.56	25.24^{c}	2.74	56.23^{cd}	1.63	27.93^{ab}	1.02	31.75^{c}	0.89	62.76^{abc}	3.03
Cumulative	**34.20**	**1.77**	**6.78**	**0.65**	**1.77**	**0.16**	**4.89**	**0.66**	**23.77**	**2.13**	**52.92**	**2.25**	**27.35**	**2.31**	**27.68**	**3.09**	**62.73**	**2.38**

$^{a\text{-}d}$Mean values with different letters shows significant ($p<0.05$) results within the columns during spring season.

Table 2. Chemical composition (%) of maize fodder collected from various localities of Punjab during autumn season.

Locality	Dry matter (%)		Crude Protein (%)		Crude Fat (%)		Crude Ash (%)		Crude Fiber (%)		Neutral Detergent fiber (%)		Acid Detergent Fiber (%)		Starch (%)		Nitrogen free extract (%)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Kasur	35.17^{bc}	4.93	6.73^{a}	0.94	1.73^{a}	0.15	4.42^{a}	0.57	23.15^{a}	4.67	47.94^{a}	2.50	24.82^{a}	2.71	22.28^{a}	2.68	63.94^{d}	5.22
Pakpattan	33.51^{ab}	2.84	7.39^{ab}	0.80	1.74^{a}	0.15	4.44^{a}	0.28	24.22^{a}	2.79	48.69^{ab}	1.58	25.04^{a}	1.87	22.94^{ab}	2.50	62.18^{abc}	2.84
Okara	31.97^{a}	0.61	8.51^{d}	0.87	1.77^{a}	0.17	4.43^{a}	0.35	24.02^{a}	1.20	48.51^{ab}	1.55	25.46^{a}	1.65	24.98^{c}	2.48	61.25^{a}	1.95
Burewala	31.73^{a}	1.09	7.03^{ab}	0.57	1.69^{a}	0.17	5.30^{b}	0.70	24.51^{a}	1.40	48.82^{ab}	0.98	25.60^{a}	1.70	28.21^{d}	2.38	61.44^{bc}	1.60
Sahiwal	31.48^{a}	1.35	7.71^{bcd}	1.10	1.76^{a}	0.12	4.48^{a}	0.34	23.15^{a}	1.00	48.82^{ab}	1.16	25.52^{a}	1.15	22.92^{ab}	1.75	62.87^{abc}	1.31
Lahore	36.94^{c}	8.98	6.81^{a}	0.82	1.76^{a}	0.13	4.55^{a}	0.37	23.24^{a}	1.02	49.21^{b}	1.21	25.51^{a}	1.50	24.35^{bc}	1.90	63.62^{bc}	1.27
Melsi	32.34^{a}	1.44	7.95^{cd}	1.96	1.75^{a}	0.14	4.42^{a}	0.29	23.22^{a}	0.94	49.43^{b}	1.66	26.26^{a}	1.77	25.58^{c}	2.26	62.64^{abc}	2.30
Cumulative	**33.30**	**3.03**	**7.45**	**0.65**	**1.74**	**0.14**	**4.57**	**0.41**	**23.64**	**1.86**	**48.77**	**1.52**	**25.45**	**1.76**	**24.46**	**2.27**	**62.56**	**2.35**

$^{a-d}$Mean values with different letters shows significant ($p<0.05$) results within the columns during autumn season.

Table 3. Mean (%) energy parameters of maize fodder collected from various localities of Punjab during spring season.

Locality	Total digestible nutrient (%)		Digestible energy (Mcal/kg)		Metabolizable energy (Mcal/kg)		Net energy for lactation (Mcal/kg)		Net energy for growth (Mcal/kg)		Net energy for maintenance (Mcal/kg)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Kasur	63.44^{a}	2.23	2.79^{a}	0.09	2.29^{a}	0.08	1.67^{a}	0.05	4.26^{a}	0.09	1.40^{a}	0.05
Pakpattan	65.43^{c}	1.02	2.88^{c}	0.04	2.36^{b}	0.03	1.72^{c}	0.02	4.34^{c}	0.04	1.45^{c}	0.02
Okara	64.74^{bc}	1.35	2.85^{bc}	0.05	2.34^{abc}	0.04	1.70^{bc}	0.03	4.31^{bc}	0.05	1.43^{abc}	0.03
Burewala	64.24^{abc}	2.13	2.83^{abc}	0.09	2.32^{abc}	0.07	1.69^{abc}	0.05	4.29^{abc}	0.09	1.42^{abc}	0.05
Sahiwal	65.14^{bc}	0.60	2.87^{bc}	0.02	2.35^{bc}	0.02	1.71^{bc}	0.01	4.33^{bc}	0.02	1.44^{bc}	0.01
Lahore	63.42^{a}	1.93	2.79^{a}	0.08	2.29^{a}	0.07	1.67^{a}	0.04	4.26^{a}	0.08	1.39^{a}	0.05
Melsi	64.01^{ab}	2.15	2.82^{ab}	0.09	2.31^{ab}	0.07	1.68^{ab}	0.05	4.28^{ab}	0.09	1.41^{ab}	0.05
Cumulative	***64.34***	***1.63***	***2.83***	***0.06***	***2.32***	***0.05***	***1.69***	***0.03***	***4.29***	***0.06***	***1.42***	***0.03***

$^{a-b}$Mean values with different letters shows significant ($p<0.05$) results within the columns during spring season.

Table 4. Mean (%) energy parameters of maize fodder collected from various localities of Punjab during autumn season.

Locality	Total digestible nutrient (%)		Digestible energy (Mcal/kg)		Metabolizable energy (Mcal/kg)		Net energy for lactation (Mcal/kg)		Net energy for growth (Mcal/kg)		Net energy for maintenance (Mcal/kg)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Kasur	65.13^{b}	3.65	2.87^{b}	0.16	2.35^{b}	0.13	1.71^{b}	0.09	4.33^{b}	1.16	1.44^{b}	1.0
Pakpattan	64.13^{ab}	2.01	2.82^{ab}	0.08	2.31^{ab}	0.07	1.69^{ab}	0.05	4.28^{ab}	0.08	1.41^{ab}	0.05
Okara	63.97^{ab}	1.01	2.82^{ab}	0.04	2.31^{ab}	0.03	1.68^{ab}	0.02	4.28^{ab}	0.04	1.41^{ab}	0.02
Burewala	63.34^{a}	1.23	2.79^{a}	0.05	2.28^{a}	0.04	1.67^{a}	0.03	4.25^{a}	0.05	1.39^{a}	0.03
Sahiwal	64.76^{ab}	0.64	2.85^{ab}	0.02	2.34^{ab}	0.02	1.70^{b}	0.01	4.31^{ab}	0.02	1.43^{ab}	0.01
Lahore	65.02^{b}	0.61	2.86^{b}	0.02	2.35^{b}	0.02	1.71^{b}	0.01	4.32^{b}	0.02	1.44^{b}	0.01
Melsi	64.68^{ab}	0.99	2.85^{ab}	0.04	2.33^{ab}	0.03	1.70^{ab}	0.02	4.31^{ab}	0.04	1.43^{ab}	0.02
Cumulative	***64.43***	***1.44***	***2.83***	***0.05***	***2.32***	***0.04***	***1.69***	***0.03***	***4.29***	***0.20***	***1.42***	***0.16***

$^{a-b}$Mean values with different letters shows significant ($p<0.05$) results within the columns during autumn season.

Table 5. Comparison of dry matter (%) of maize fodder collected from various localities of Punjab during spring and autumn season.

LOCALITY	SEASON				*p VALUE*
	SPRING		AUTUMN		
	Mean	**SD**	**Mean**	**SD**	
Kasur	34.40^{c}	1.42	35.17^{bc}	4.93	0.650
Pakpattan	31.96^{a}	1.37	33.51^{ab}	2.84	0.010
Okara	32.51^{ab}	1.69	31.97^{a}	0.61	0.281
Burewala	32.20^{a}	0.69	31.73^{a}	1.09	0.240
Sahiwal	32.26^{a}	1.39	31.48^{a}	1.35	0.102
Lahore	34.02^{bc}	3.67	36.94^{c}	8.98	0.245
Melsi	42.08^{d}	2.16	32.34^{a}	1.44	0.000

$^{a-d}$Mean values with different letters shows significant ($p<0.05$) results between columns during spring and autumn season.

Data was further computed for the assessment of seasonal variation in nutritional parameters. Crude protein (CP) refers to all the nitrogenous compounds present in forage feed/fodder. It is considered a reliable source of overall nutritional status of fodder. Fodder high in Protein contents is also mostly higher in other nutrient content such as vitamins and minerals i.e. calcium and phosphorus. All these features are directly related to the amount of crude protein because it has been observed that they decline with low crude protein, to almost poor levels (Ganskopp and Bohner, 2001).

Table 5 shows the dry matter content of maize fodder harvested during spring and autumn season. It was revealed that highly significant elevated dry matter content were observed during spring season in samples collected from Melsi with the value of 42.08%. While Pakpattan showed significant value of 33.51% during autumn season. Other four areas (Kasur, Okara, Burewala and Sahiwal) showed non-significant difference for both spring and autumn season. It was observed that dry matter of fodder crops in the form of grasses and shrubs generally increased with maturity. The results agree with other studies (Vallentine, 1990; Ashraf et al., 1995; Kramberger and Klemencic, 2003) who also observed increased dry matter with maturity of fodder plants.

Table 6. Comparison of crude protein (%) of maize fodder collected from various localities of Punjab during spring and autumn season.

LOCALITY	SEASON				p VALUE
	SPRING		AUTUMN		
	Mean	SD	Mean	SD	
Kasur	6.79^{b}	0.60	6.73^{a}	094	0.860
Pakpattan	6.85^{b}	1.04	7.39^{abc}	0.80	0.026
Okara	7.26^{b}	0.93	8.51^{d}	0.87	0.003
Burewala	6.78^{b}	0.61	7.03^{ab}	0.57	0.304
Sahiwal	7.05^{b}	0.71	7.71^{bcd}	1.10	0.024
Lahore	7.35^{b}	1.14	6.81^{a}	0.82	0.159
Melsi	5.41^{a}	0.54	7.95^{cd}	1.96	0.000

$^{a-d}$Mean values with different letters shows significant ($p<0.05$) results between columns during spring and autumn season.

Table 7: Comparison of crude fat (%) content of maize fodder collected from various localities of Punjab during spring and autumn season.

LOCALITY	SEASON				p VALUE
	SPRING		AUTUMN		
	Mean	SD	Mean	SD	
Kasur	1.73[a]	0.15	1.73[a]	0.15	0.985
Pakpattan	1.77[a]	0.15	1.74[a]	0.15	0.498
Okara	1.76[a]	0.13	1.77[a]	0.17	0.916
Burewala	1.71[a]	0.19	1.69[a]	0.17	0.809
Sahiwal	1.83[a]	0.17	1.76[a]	0.12	0.155
Lahore	1.77[a]	0.19	1.76[a]	0.13	0.880
Melsi	1.86[a]	0.20	1.75[a]	0.14	0.050

[a-d]Mean values with different letters shows significant ($p<0.05$) results between columns during spring and autumn season.

Protein content is a basic parameter to be considered during the selection of any feed/ fodder for the animals. Table 6 shows the crude protein contents of maize fodder harvested during spring and autumn season. Data revealed that significantly elevated protein contents were observed during autumn season in samples collected from Pakpattan, Okara, Sahiwal and Melsi with the values of 7.39%, 8.51%, 7.71% and 7.95% respectively. These variations in crude protein content of maize fodder could be a result of many important agronomic factors that are application of nitrogen fertilizers at various levels of growth, harvesting time of crop, and storage techniques.

Table 7 shows the crude fat/ ether extract (EE) contents of maize fodder harvested during spring and autumn season. It is evident that non-significant contents were observed during spring and autumn season in all the samples collected from Kasur, Pakpattan, Burewala, Okara, Sahiwal, Lahore and Melsi. However, samples collected from Melsi showed significantly elevated oil content during spring season.

Table 8: Comparison of crude ash (%) content in maize fodder collected from various localities of Punjab during spring and autumn season.

LOCALITY	SEASON				p VALUE
	SPRING		AUTUMN		
	Mean	SD	Mean	SD	
Kasur	5.78[b]	1.00	4.42[a]	0.57	0.000
Pakpattan	4.72[a]	0.64	4.44[a]	0.28	0.029
Okara	4.95[a]	0.73	4.43[a]	0.35	0.030
Burewala	4.52[a]	0.44	5.30[b]	0.70	0.005
Sahiwal	4.73[a]	0.63	4.48[a]	0.34	0.197
Lahore	4.86[a]	0.66	4.55[a]	0.37	0.148
Melsi	4.71[a]	0.56	4.42[a]	0.29	0.039

[a-d]Mean values with different letters shows significant (p<0.05) results between columns during spring and autumn season.

Table 9: Comparison of crude fiber (%) of maize fodder collected from various localities of Punjab during spring and autumn season.

LOCALITY	SEASON				p VALUE
	SPRING		AUTUMN		
	Mean	SD	Mean	SD	
Kasur	23.89[abc]	3.22	23.15[a]	4.67	0.66
Pakpattan	22.42[a]	1.18	24.22[a]	2.79	0.002
Okara	22.92[ab]	1.24	24.02[a]	1.20	0.041
Burewala	24.20[bc]	2.90	24.51[a]	1.40	0.72
Sahiwal	22.83[ab]	1.21	23.15[a]	1.00	0.41
Lahore	24.89[c]	2.42	23.24[a]	1.02	0.030
Melsi	25.24[c]	2.74	23.22[a]	0.94	0.001

[a-d]Mean values with different letters shows significant (p<0.05) results between columns during spring and autumn season.

Table 10: Comparison of Neutral detergent fiber (%) of maize fodder collected from various localities of Punjab during spring and autumn season.

LOCALITY	SEASON				p VALUE
	SPRING		AUTUMN		
	Mean	SD	Mean	SD	
Kasur	56.96[d]	2.07	47.94[a]	2.50	0.000
Pakpattan	54.21[bcd]	4.90	48.69[ab]	1.58	0.000
Okara	48.32[ab]	1.47	48.51[ab]	1.55	0.765
Burewala	59.18[d]	2.96	48.82[ab]	0.98	0.000
Sahiwal	45.88[a]	1.48	48.82[ab]	1.16	0.483
Lahore	49.69[ab]	1.24	49.21[b]	1.21	0.259
Melsi	56.23[cd]	1.63	49.43[b]	1.66	0.000

[A-dMean] values with different letters shows significant ($p<0.05$) results between columns during spring and autumn season.

Ash content/inorganic matter of fodder plays an important role in promoting balanced growth of livestock. Table 8 shows the crude ash content of maize fodder harvested during spring and autumn season. It is highly significant for Kasur with 5.78% value. Significantly elevated levels of crude ash content were observed during spring season in samples collected from Pakpattan, Okara, Burewala and Melsi with the values of 4.72%, 4.95%, 4.52% and 4.71% respectively.

Mature plants of maize fodder usually contained high CF than young plants. Seasonal variation also affects the crude fiber contents (Azim et al., 1989). Crude fiber is less nutritional than cell contents due to its slow digestibility. Furthermore, annual grasses showed greater decline in nutritive quality than the perennial grasses (Holechek et al., 1998). Table 4.9 revealed that significantly elevated crude fiber content were observed during spring season in samples collected from Pakpattan, Okara, Lahore and Melsi with the values of 22.42%, 22.92%, 24.89% and 25.24% respectively. There are two main factors for this increase of fiber contents in maize plants. Crude fiber was higher at reproductive and post reproductive stages. Since in spring season harvesting is done when climate is hot and more water loss from plant body took place. In addition, water level decreased with the increase of temperature.

Table 10 shows the neutral detergent fiber of maize fodder harvested during spring and autumn season. Highly significant elevated levels of neutral detergent fiber were observed during spring season in samples collected from Kasur, Pakpattan, Burewala, and Melsi with the values of 56.96%, 54.21%, 59.18% and 56.23% respectively. Other three areas such as Okara, Sahiwal and Lahore showed non-significant difference for both spring and autumn season with values of 48.32%, 45.88% and 49.59% respectively. There are

two main factors for this increase or decrease of neutral detergent fiber in plants grown in spring and autumn season. It may be due to variation in climatic conditions and maturity of plants. The results agree with other studies carried out by Ganskopp and Bohner (2001); Kramberger and Klemencic (2003) and Sultan et al. (2007), which reported increase in NDF concentration with maturity of plants.

Table 11: Comparison of acid detergent fiber (%) of maize fodder collected from various localities of Punjab during spring and autumn season.

LOCALITY	SEASON				p VALUE
	SPRING		AUTUMN		
	Mean	SD	Mean	SD	
Kasur	26.25[a]	2.42	24.82[a]	2.71	0.168
Pakpattan	27.46[a]	2.28	25.04[a]	1.87	0.011
Okara	26.33[a]	1.96	25.46[a]	1.65	0.255
Burewala	26.65[a]	2.60	25.60[a]	1.70	0.221
Sahiwal	29.12[b]	4.19	25.52[a]	1.15	0.004
Lahore	27.71[ab]	1.73	25.51[a]	1.50	0.001
Melsi	27.93[ab]	1.02	26.26[a]	1.77	0.007

[a-d]Mean values with different letters shows significant ($p<0.05$) results between columns during spring and autumn season.

Table 11 shows the acid detergent fiber of maize fodder harvested during spring and autumn season. It is revealed that non-significant levels of acid detergent fiber were observed during spring season in samples collected from Kasur, Pakpattan, Okara and Burewala with the values of 26.25%, 27.46%, 26.33% and 26.65% respectively. Sahiwal, Lahore and Melsi showed non-significant difference for both spring and autumn season with values of 29.12%, 27.71% and 27.93% respectively. There are two main factors for this increase or decrease of acid detergent fiber in plants grown in spring and autumn season. It may be due to variation in climatic conditions and maturity of plants. The results agree with other studies done by Kramberger and Klemencic (2003); Sultan et al., (2007), which reported increase in NDF concentration with maturity of plants. Similarly, Ashraf et al. (1995) observed increase in NDF and ADF in fodder species at different growth stages and our results agree with them.

Table 12: Comparison of starch (%) of maize fodder collected from various localities of Punjab during spring and autumn season.

LOCALITY	SEASON				p VALUE
	SPRING		AUTUMN		
	Mean	SD	Mean	SD	
Kasur	30.33^{c}	3.19	22.28^{a}	2.68	0.000
Pakpattan	26.84^{b}	5.11	22.94^{ab}	2.50	0.000
Okara	22.17^{a}	5.62	24.98^{c}	2.48	0.110
Burewala	30.65^{c}	1.83	28.21^{d}	2.38	0.011
Sahiwal	29.99^{c}	2.97	22.92^{ab}	1.75	0.000
Lahore	22.07^{a}	2.03	24.35^{bc}	1.90	0.005
Melsi	31.75^{c}	0.89	25.58^{c}	2.26	0.000

$^{a-d}$Mean values with different letters shows significant ($p<0.05$) results between columns during spring and autumn season.

Table 13: Comparison of nitrogen free extract (%) of maize fodder collected from various localities of Punjab during spring and autumn season.

LOCALITY	SEASON				p VALUE
	SPRING		AUTUMN		
	Mean	SD	Mean	SD	
Kasur	61.79^{ab}	3.07	63.94^{d}	5.22	0.251
Pakpattan	64.22^{c}	1.73	62.18^{abc}	2.84	0.002
Okara	63.07^{bc}	2.09	61.25^{a}	1.95	0.039
Burewala	62.76^{abc}	2.87	61.44^{bc}	1.60	0.144
Sahiwal	63.54^{bc}	0.93	62.87^{abc}	1.31	0.068
Lahore	61.11^{a}	3.00	63.62^{bc}	1.27	0.009
Melsi	62.76^{abc}	3.03	62.64^{abc}	2.30	0.896

$^{a-d}$Mean values with different letters shows significant ($p<0.05$) results between columns during spring and autumn season.

High level of starch (carbohydrate) in fodder plants like maize is considered better than high lignin content as they provide readily available energy. They are easily digestible. It is of prime importance because its requirement cannot be ordinarily compensated by protein (Holechek et al., 1998). Many studies show a progressive increase in the carbohydrate content from pre-reproductive to post-reproductive stages. However, high carbohydrate content at late phenological stage of maize become less beneficial to livestock due to its low digestibility in the form of celluloses and hemi-celluloses. Table 12 shows the starch content of maize fodder harvested during spring and autumn season. Highly significant elevated levels of starch were observed during spring season in samples collected from Kasur, Pakpattan, Sahiwal and Melsi with the values of 30.33%, 26.84%, 29.99% and 31.75% respectively. Okara and Burewala showed non-significant difference for both spring and autumn season with values of 22.17% and 30.65% respectively. Samples collected from Lahore showed significantly increased levels in autumn season when compared with the samples collected during spring season.

Table 13 shows the nitrogen free extract (NFE) content of maize fodder harvested during spring and autumn season. Kasur, Burewala, Sahiwal and Melsi showed non-significant difference with values of 63.94%, 62.76%, 63.54% and 62.76% respectively with respect to nitrogen free extract (NFE) in spring and autumn season. Pakpattan, Okara and Lahore showed significant difference with respect to (NFE). According to studies done by Cook and Stubbendieck (1986), NFE values in many types of forage are nearly equal to each other. It might be due to variation in climatic conditions and maturity of plants.

The metabolizable energy (ME) is an amount of energy available to the animal. While digestible energy is the energy of food subtracted from the energy lost in the form of feces. Total digestible nutrients (TDN) is analogous/comparable to DE but includes digestible proteins (NRC, 2001). Total digestible nutrient (TDN) is an aggregation of digestible fiber, fat, protein and carbohydrates of diet/silage etc. It is directly related to the digestible energy and usually estimated based upon ADF. Net energy (NE) is mentioned to as net energy for maintenance (NEM), net energy for gain (NEG), and net energy for lactation (NEL). The net energy system splits the energy requirements into their fractional components used for tissue maintenance, tissue gain, and lactation. The graphical expression of different energy parameters are shown in Figures 2 to 7. In present study, data was further computed for the energy parameters as discussed above. In successive session individually these parameters were discussed.

In spring season high total digestible nutrient (TDN) level was observed in Pakpattan, Okara and Sahiwal while it was low in Kasur, Burewala, Lahore and Melsi (Figure 2). In autumn season high total digestible nutrient (TDN) was observed in Kasur, Sahiwal, Lahore and Melsi. On the other side Pakpattan, Okara, and Burewala were low with respect to total digestible nutrient (TDN) in autumn. The possible reason for high value may be the environmental conditions which are more favorable for maize.

As evinced from Figure 3, in spring season high (DE) level was observed in Pakpattan, Okara and Sahiwal while it was low in Kasur, Burewala, Lahore and Melsi. DE was low in autumn season in Pakpattan, Okara, and Burewala and it was high in Kasur, Sahiwal, Lahore and Melsi. The possible reason for the high value may be the elevated level of starch in spring and autumn season. Burewala showed significant difference with respect to DE in spring and

autumn season as compared to other areas. It depended upon agronomic practices. Pakpattan and Sahiwal showed significantly high values for ME in spring and autumn season (Figure 4). Metabolizable energy is low in autumn season in Pakpattan, Okara and Burewala while it was high in Kasur, Sahiwal and Lahore. The possible reason for same values in pakpattan and Okara may be the similar climatic conditions of the two areas. No significant variations in NEG and NEM were observed during both sampling seasons (Figure 6; Figure 7).

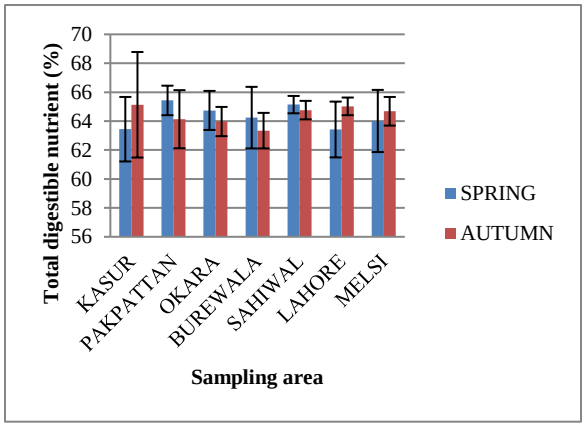

Figure 2. Comparison of total digestible nutrient (%) of maize fodder collected from various areas of Punjab during spring and autumn season. Error bars show standard error with 95 % confidence interval.

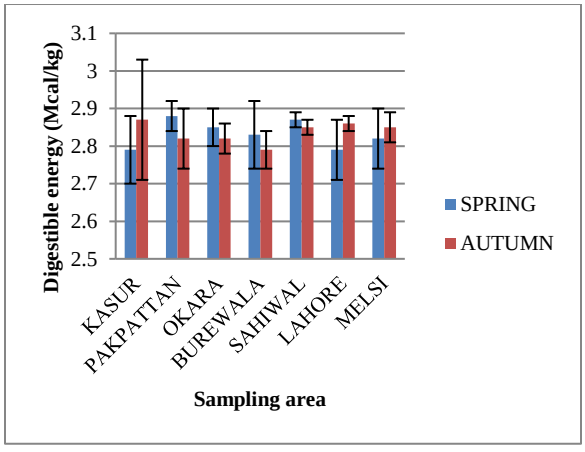

Figure 3. Digestible energy (Mcal/kg) of maize fodder collected from various areas of Punjab during spring and autumn season. Error bars show standard error with 95 % confidence interval.

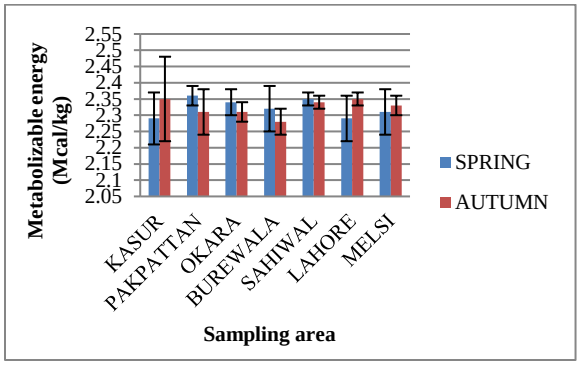

Figure 4. Metabolizable energy (Mcal/kg) of maize fodder collected from various areas of Punjab during spring and autumn season. Error bars show standard error with 95 % confidence interval.

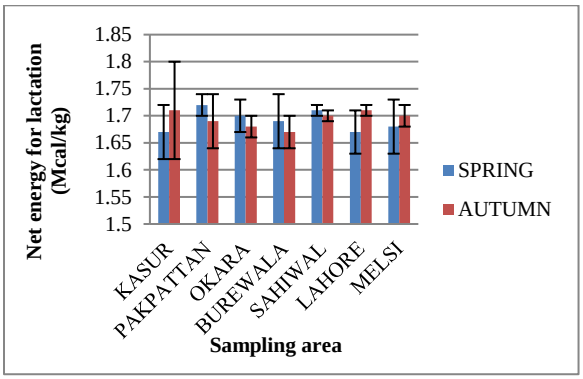

Figure 5. Energy for lactation (Mcal/kg) of maize fodder collected from various areas of Punjab during spring and autumn season. Error bars show standard error with 95 % confidence interval.

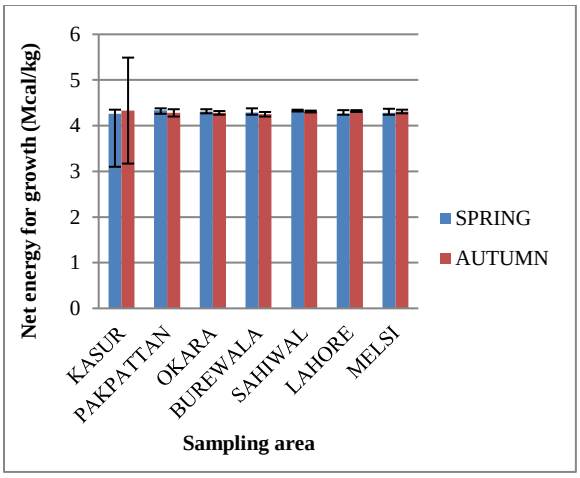

Figure 6. Energy for growth (Mcal/kg) of maize fodder collected from various areas of Punjab during spring and autumn season. Error bars show standard error with 95 % confidence interval.

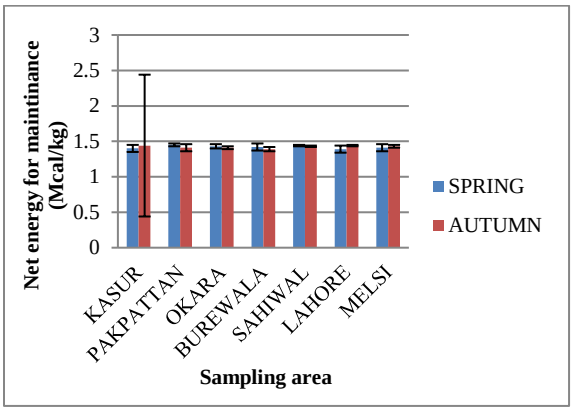

Figure 7. Energy for maintenance (Mcal/kg) of maize fodder collected from various areas of Punjab during spring and autumn season. Error bars show standard error with 95 % confidence interval.

Maize is used not only as fodder but also for making silage in Punjab. Central and southern Punjab is considered well as areas for cultivation of maize. Maize needs warm climatic conditions for its proper growth. The climatic conditions of these areas of Punjab enable farmers to grow maize twice in a year. Therefore samples were collected from Kasur, Pakpattan, Burewala, Sahiwal, Lahore and Melsi. Present study was conducted to evaluate the seasonal effect on nutritional value of maize grown in spring and autumn seasons. The samples were analyzed for different nutritional parameters. During spring season, at the time of cultivation of maize the environment is mild and suitable for growth of maize in all respects. Therefore, maize fodder is enriched with nutrients at early stages of growth. Since it is harvested in summer season, the climatic conditions are harshen which gradually reduces the amount of protein due to the formation of dry matter/ crude fiber. It was concluded after the statistical analysis that during spring season, the values of dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF) and starch were significantly higher than autumn season values. At this stage fodder is low with respect to its nutritional value. Therefore, it should be used at early growth stage, at half milk line stage, not for use as fodder but also for silage making. On the other hand, crude protein (CP) content was higher in maize grown in autumn season along with low amount of dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF) and starch. It is more desirable for the health of livestock with respect to nutrition.

CONCLUSION

It was concluded that maize grown in autumn season has high nutritional value than spring season maize. However, it is more appropriate if the crop is harvested a bit earlier in the month during May-June for the better nutritional values which were observed during spring samplings.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

AOAC (2000). Official Methods of Analysis. Association of Official Analytical Chemists. 17th ed. Gaithersburg, Maryland, USA.

Ashraf Y, Gilani AH and Nagra SA (1995). Effect of harvesting interval and varieties on the chemical composition of indigenous fodder. I: Proximate Composition. J Agric Res., 33: 31-43.

Ayub M, Nadeem MA, Sharar MS and Mahmood N (2002). Response of maize fodder to different levels of nitrogen and phosphorus. Asian J of Plant Sci., 1: 352-354.

Azim A, Naseer Z and Ali A (1989). Nutritional evaluation of maize fodder at two different vegetative stages. Aust J Agric Res., 2: 27 -34.

Cook CW and Stubbendieck J (1986). Range Research, Basic Problems and Techniques. Society for Range Management, Colorado.

Enyisi SI, Lemoh VJ, Whong CMZ, AbdulIahi IO and Alabi O (2014). Chemical and nutritional value of maize and maize products obtained from selected markets in Kaduna state, Nigeria. African J Food Sci Technol., 5 (4): 100-104.

Ganskopp D and Bohnert D (2001). Nutritional dynamics of 7 northern Great basin grasses. J Range Manage., 54: 640-647.

Holechek JL, Pieper RD and Herba CH (1998). Range Management. Principles and Practices. 3rd ed. Prentice Hall, New Jersey.

Khan F, Khan S, Fahad S, Faisal S, Hussain S, Ali S and Ali A (2014). Effect of different levels of nitrogen and phosphorus on the phenology and yield of Maize Varieties. American J Plant Sci., 5: 2582–2590.

Kramberger B and Klemencic S (2003). Effect of harvest date on the chemical composition and nutrient value of *Ceratium holosteoides*. Grass Forage Sci., 58: 12-16.

National Research Council (2001). Nutrient requirements of dairy cattle. 7th Revised Ed., Subcommittee on Dairy Cattle Nutrition, Committee on Animal Nutrition, Board on Agriculture and Natural Resources, National Research Council, National Academy Press, Washington, D.C.

Pakistan Economic Survey (2018-19). Ministry of Finance, Islamabad: pp 18.

Siddique M, Bajawa MS and Makhdum MI (1989). Yield and quality of maize fodder as influenced by different stages of harvesting and nitrogen rates. Pakistan J Sci Indust Res., 32: 766-67.

Sultan JI, Inamur R, Nawaz H and Yaqoob M (2007). Nutritive value of marginal land grasses of Northern Grasslands of Pakistan. Pak J Bot., 39: 1071-1082.

Tariq M and Iqbal H (2010). Maize in Pakistan-An overview. J Nat Sci., 44: 757 – 763.

Touqir NA, Khan MA, Sarwar M, Nisa MU, Ali CS, Lee WS, Lee HJ and Kim HS (2007). Feeding value of Jambo grass silage and Mott grass silage for lactating Nili buffaloes. Asian-Aust J Anim Sci., 20: 523-528.

Vallentine JF (1990). Grazing Management. Academic Press, USA.